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# *SHAPING EXHALE DURATIONS FOR BREATH CO DETECTION FOR MEN WITH MILD MENTAL RETARDATION*

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Roll, Higgins, and Badger (1996) used a carbon monoxide (CO) detector to determine whether participants smoked in a smoking-cessation study. We sought to replicate their work with adults with mild mental retardation. However, verbal instructions were inadequate to establish stable exhalations of sufficient durations for reliable and accurate CO evaluation. This report describes a shaping procedure that enabled 3 of 4 participants to achieve 20-s exhalation durations.

DESCRIPTORS: exhale durations, carbon monoxide, mental retardation, smoking-cessation program, changing criterion design

Many individuals with mild mental retardation are chronic cigarette smokers (Hymowitz, Jaffe, Gupta, & Feuerman, 1997), yet little attention has been paid to developing smoking-cessation programs for this population. For individuals without disabilities, monetary reinforcement for smoking abstinence, as assessed by breath carbon monoxide levels, has reduced smoking (e.g., Roll, Higgins, & Badger, 1996). Our initial goal was to apply these procedures to smokers with mild mental retardation. None of our volunteers, however, could adequately follow the usual instructions to "take a deep breath, hold it for 15 seconds, and exhale slowly." Specifically, participants exhaled too quickly. This resulted in highly variable CO readings and readings that indicated nonsmoking in known heavy smokers. There was no information on the optimal exhalation duration in the literature involving similar CO detectors. Our measurements with smokers without disabilities showed the highest and most stable CO readings with 20-s exhale durations (breath-hold duration of 15 s). The first 4 volunteers for our smoking cessation program could hold their breath for 15 s, but none exhaled for 20 s. Thus, we attempted to establish 20-s exhale durations prior to beginning the cessation program (i.e., dividing the task into different steps; Wong, Seroka, & Ogisi, 2000). We used a changing criterion design to shape 20-s exhalations, a kitchen timer to signal the required durations, and verbal praise for meeting exhale-duration criteria.

## METHOD

### *Participants*

The participants were 4 men (Bill, 43 years old; Chuck, 24 years old; Pete, 22

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years old; and Robbie, 36 years old) with mild mental retardation who volunteered for a smoking-cessation program. Their Fagerstrom Smoking Questionnaire scores ranged from 6 to 9, indicating moderate to high addiction (Fagerstrom & Schneider, 1989). Participants were verbal and could usually follow multistep instructions. They were promised $3.00 for completion of training.

*Apparatus*

The CO detector was a MICRO II Smokerlyzer (Bedford Industries, Medford, NJ) that was calibrated according to the manufacturer's directions. Because it was difficult to detect exhalation duration, a piece of Christmas tree tinsel was taped to the center of the output end of the cardboard mouthpiece (during baseline and training) or to the exhaust port of the CO detector during posttest. The tinsel allowed observers to time exhalations accurately so that feedback for shaping duration could be provided and interobserver agreement measures could be obtained. When the participant exhaled, the tinsel moved. The tinsel was affixed so that only 5/8 in. was exposed to the airflow (to reduce danger of aspiration), and it was visible to the observer, but not to the participant. Two timers were used; one timer was set for the breath-holding criterion and the other was set for the exhalation criterion. Both timers were visible to participants and observers.

*Procedure*

*Measurement and reliability.* The duration of tinsel movement was recorded to the nearest second. Breath holding was recorded as the time from closing the mouth (with nose held closed) to tinsel movement. A second observer independently and concurrently recorded durations on all of the baseline and posttesting sessions. An agreement was scored for a trial when both observers recorded durations within 1 s of each other. Reliability was calculated as number of trials with agreement divided by the number of trials conducted (three) for each session.

*Baseline breath-hold and exhalation measures.* Each participant was instructed to hold his breath (holding nose and closing mouth) as long as possible and exhale into the mouthpiece as long as possible for three trials. The mouthpiece was disconnected from the CO detector.

*Training.* One or two three-trial sessions were conducted each weekday. For each trial, a digital timer was set to the criterion number of seconds and placed in the participant's view. The participant was instructed to take a deep breath and then blow it out slowly for the criterion number of seconds. As with baseline, the participant blew into the mouthpiece, which was disconnected from the machine. The trial ended when the participant exhaled for the criterion duration, or when the participant had ceased exhaling (defined as either 1 s without movement of the tinsel or as the intake of breath). Praise was provided for meeting criterion.

The criterion duration was initially set within the participant's baseline range. After at least one session in which the criterion was met on all three trials, the criterion was increased by 1 s for the next session. If the target duration was not achieved in two sessions, the criterion was reduced by 1 s. Once the 20-s criterion for exhaling had been met, the 15-s breath-holding requirement was added.

*Posttest.* After a participant reached criterion for breath holding and exhale duration with the mouthpiece detached, the mouthpiece was attached to the CO detector for final measures of breath holding and exhalation duration. Participants could still view the timer and were told the duration criteria.

*CO levels.* One week later, baseline CO levels were collected for all participants (except Bill), as part of the smoking-cessation program.

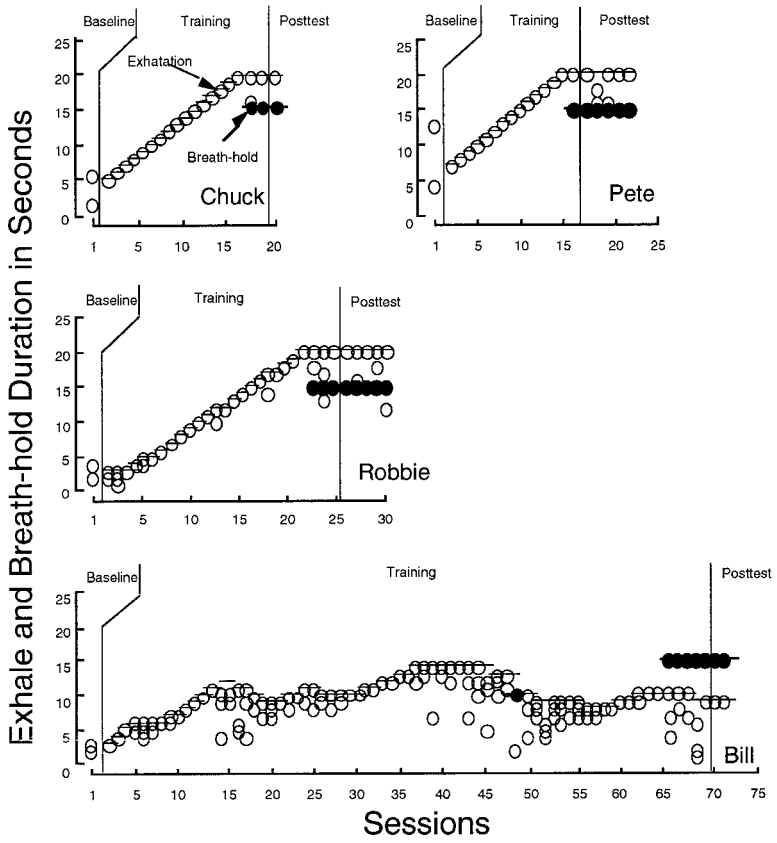


Figure 1. Trial-by-trial durations of exhalation and breath holding for each session for the 4 participants. Open circles indicate durations of exhalations. Filled symbols indicate obtained breath-holding durations. Horizontal lines through open symbols indicate the exhalation criterion, and horizontal lines through filled symbols indicate the breath-holding criterion for that trial. Data for all three trials per session are plotted; when values are identical, the symbols appear as one.

## RESULTS AND DISCUSSION

Mean reliability during baseline was 83% (range, 67% to 100%) for breath-holding durations and 92% (range, 67% to 100%) for exhalation durations. Observers agreed on 10 of 12 breath holds and 11 of 12 exhalations. The difference between the two observers' scores never exceeded 2 s. The posttesting reliability measures (mouthpiece attached to the CO detector) were 100% for breath holding and exhalation durations on all sessions.

In the three baseline trials, all participants held their breath for the target duration. Exhale durations, however, were brief or inconsistent. The highest exhalation durations for the 4 participants ranged from 3 to 13 s.

Figure 1 shows training performance for each participant. For Chuck, Pete, and Robbie, exhale training proceeded rapidly with few subcriterion trials. There was an initial transient disruption in performance for Chuck and Robbie when breath-holding durations were added to exhalation durations. Disruption in performance for Robbie was somewhat longer. For Pete, there were two posttest sessions in which at least one exhalation criterion was not met. There were three posttest sessions in which Robbie did not meet criterion on one of three exhalation

trials. One week later, baseline CO levels were collected. Peak CO levels were 24 parts per million (ppm) for Chuck and 22 ppm for Robbie, which indicated heavy smoking. Pete's CO level was 20 ppm, which indicated light smoking.

For Bill, training progressed slowly, and there was much variability in his exhalation durations. He achieved only 9-s exhalation durations after numerous interventions. In addition, without the authors' knowledge, he began using a transdermal nicotine patch and reduced smoking near the end of training.

In summary, the goal of this study was largely met. For 3 of 4 participants, simple shaping procedures were effective in teaching 20-s exhalation durations. One participant did not reach the criterion, perhaps because praise was a weak reinforcer. Another possibility is that meeting these criteria may have been physically challenging for Bill, due to a chronic cough and shortness of breath that his physician attributed to smoking. In addition, the benefit of using the tinsel allowed precise reinforcement of exhalation and interobserver agreement.

One limitation to this study is that interobserver agreement was not collected during training. High interobserver agreement during baseline and posttest, however, indicated that the trainer discriminated exhalation duration.

Finally, it may be important for researchers in the smoking-cessation field to establish stable exhalation criteria that maximize CO readings. Without such criteria, some participants could smoke and provide a short exhalation that would not detect smoking.

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